

Awareness and coexistence measures to conserve endangered lion-tailed macaques in the Valparai landscape, Western Ghats

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Executive Summary

Objectives: The lion-tailed macaque is an endangered primate, endemic to Western Ghats rainforests, India. This arboreal primate, affected by forest fragmentation, continues to occur in some isolated rainforest fragments, including within private tea and coffee plantations. Of 31 troops in the Anamalai hills, 12 troops occur in rainforest fragments within plantations on the Valparai plateau. Recently, macaque troops in one of the rainforest fragments near Valparai town, through which a main road passes, have shown behavioural changes, become habituated to people, and suffered more frequent road kill mortality and problems related to feeding by tourists or open waste dumping, including near homes. Finding solutions to these issues will enable the conservation of the species, reduce negative interactions with people, and build coexistence. As an initial step, we conducted a questionnaire survey to understand people's perceptions towards lion-tailed macaques and identify appropriate conflict mitigation measures.

Results: Questionnaire survey was conducted in colonies and residences in and around three rainforest fragments—Puthuthottam, Korangumudi, and Old Valparai—where lion-tailed macaque troops occur. Macaques near Korangumudi and Old Valparai rarely ventured close to residences and many people remained unaware of their presence. Respondents in and around Puthuthottam were aware of the macaques and most (68%) tend to have some negative perceptions since macaques often come close to human habitations. Most respondents (87%) were of the opinion that the macaques visited human habitations in search of food and garbage. We found that housing conditions influenced the people's perception: more people (84.5%) living in tiled-roof houses tended to have negative perceptions when compared to people living in asbestos-roof and concrete structures. Past fragmentation and ongoing habitat degradation also contributed to macaques coming to the ground and directly interacting with people more often.

Suggested measures: to reduce negative interactions and build human – macaque coexistence

- **Improving housing through monkey-proofing measures:** Simple, cost-effective modifications (monkey-proofing) of existing houses can be made after a joint assessment by stakeholders, including plantation management, forest department personnel, and NCF researchers familiar with the macaques in the area.
- **Improving garbage disposal:** continue and expand waste segregation and regular collection, including by the municipality, while implementing measures to prevent open waste disposal and feeding of macaques by tourists, residents, and others.
- **Building awareness on specific issues:** create better awareness on lion-tailed macaques, the need to stop feeding of monkeys by tourists and others, and carry out training in waste segregation, collection, and disposal.
- **Ecological restoration of rainforest fragment and retention of native shade trees in plantations:** as a long-term solution, carry out restoration of rainforest fragments, particularly Puthuthottam and Korangumudi, using suitable mixed native species (including key macaque food plants) available in the rainforest plant species nursery; retain existing native shade tree species and include such species in in tea and coffee shade planting.

Introduction

The lion-tailed macaque is listed as Endangered in the *IUCN Red List of Threatened Species* (IUCN 2013), in Appendix I of CITES, and protected under Schedule I of India's Wildlife Protection Act (Kumar et al. 2008). Habitat fragmentation is a major threat to the species, now estimated to be only around 4,000 individuals in the wild along the Western Ghats (IUCN 2013). The species is arboreal and inhabits tropical wet evergreen forest, often in isolated fragments, including rainforest fragments within private lands such as tea and coffee plantations (Mudappa and Raman 2007, Kumar et al. 2008). In the Anamalai hills, of the 31 troops of around 460 individuals of lion-tailed macaques (over 10% of the global population), 12 troops (39% of troops) and over 120 individuals (25% of the population) occur in rainforest fragments within plantations on the Valparai plateau (Singh et al. 2001, Sridhar et al. 2008).

Recently, macaque troops living in rainforest fragments close to developed areas and penetrated by roads have shown behavioural alteration and become habituated to people. The macaques have also suffered more frequent road kill mortality and were involved in incidents of conflicts with people due to feeding by tourists or monkeys visiting open waste dumps and homes. Finding solutions to these issues will enable the conservation of this species and provide a model for building human – macaque coexistence across fragmented tropical landscapes.

In this study, we aimed to understand local people's perceptions towards lion-tailed macaques, identify housing vulnerability to macaques, and people's responses in relation to their interactions with this primate species. The survey results will be used as a baseline, to identify appropriate conflict mitigation measures, and to prioritize implementation of strategies to enable coexistence.

Study site

We focus on the lion-tailed macaque population in the Valparai plateau, Anamalai hills, southern Western Ghats. The Valparai plateau is a 220 sq. km. enclave mostly under plantations of tea, coffee and *Eucalyptus*, roads and human settlements. There are over 40 rainforest fragments embedded within private plantations (Mudappa & Raman 2007). The lion-tailed macaques occur in five rainforest fragments namely Puthuthottam, Korangumudi, Pannimade, Sirikundra and Old Valparai, which are affected by habitat degradation due to fragmentation and past logging, while 3 rainforest fragments also have linear infrastructure intrusions such as roads and powerlines causing occasional macaque mortality due to roadkills or electrocution.

The present study focuses on Puthuthottam, Korangumudi, and Old Valparai rainforest fragments (Figure 1), with special attention to Puthuthotam. The latter rainforest fragment has the largest population of lion-tailed macaques (122 macaques in 2 troops, Umapathy et al. 2010; the population is now larger in 4 troops following troop splits).

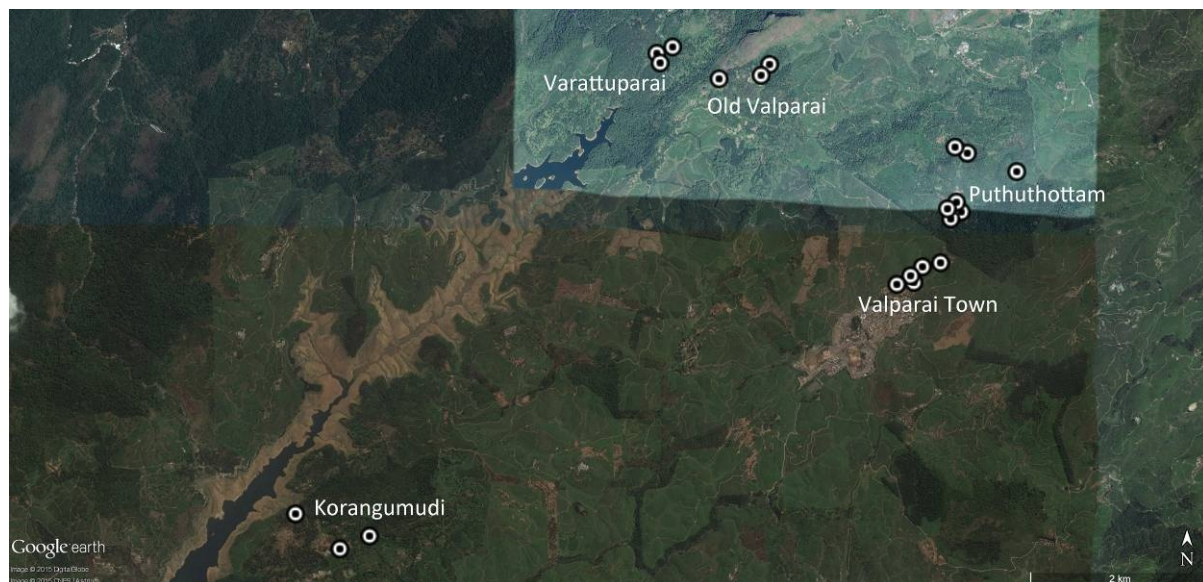


Figure 1: Map of Valparai landscape showing locations of where perception surveys were conducted for lion-tailed macaque (Image courtesy: Google Earth).

Conservation background

People in the Valparai landscape have always lived alongside various wildlife species including lion-tailed macaques. The local stakeholders, particularly the Tamil Nadu State Forest Department and various tea and coffee plantation companies are aware of the importance of this endangered species and continue to support their protection. However, conservation concerns are pronounced in the 92 ha Puthuthottam rainforest fragment, adjoining abandoned coffee and active tea plantations, in Puthuthottam Estate. The rainforest fragment abuts the densely-populated Valparai town (population: c. 30,000) and has human settlements within the estate. These macaques range over the rainforest fragment and abandoned coffee area. There has been past (1989-90, 1997-98) tree felling within the rainforest fragment and partial conversion of coffee to tea plantations (Singh *et al* 2001), and the site continues to face chronic firewood collection by local people. In recent years, the main highway to Valparai town, which passes through and bisects the rainforest fragment, has been widened and vehicular traffic and tourist influx has increased.

The continuous degradation has affected the ecology and behaviour of these arboreal lion-tailed macaques. Because of reduced canopy height, cover, and food tree availability, time spent in trees by macaques has reduced from 95.4% in 1990-91 to 70.7% in 1999-2000 (Singh *et al* 2001) and the monkeys are increasingly seen on the ground, on the main highway, and in adjoining human settlements. In the last 8 years, at least 10 lion-tailed macaques were killed on the road through Puthuthottam as they were forced to cross on the ground due to breakage of tree canopy connectivity. Four monkeys have also been electrocuted while attempting to cross on powerlines passing through their habitat.

The Puthuthottam macaques have also started entering houses (through open doors, windows, and by removing roof tiles) in the estate colonies and in Valparai town in search of food. This has resulted in conflicts with people, retaliatory chasing using firecrackers and pelting stones

and an apparent decrease in local people's tolerance towards macaques, which had been high until recently. However, it should be noted that lion-tailed macaques entering houses is a relatively recent and occasional phenomenon.

Widening of the main road to Valparai town, which passes through the rainforest fragment, has also resulted in breakage in tree canopy connectivity and increased canopy gap above the road. Therefore, the lion-tailed macaques are forced to cross the road on the ground. This also enables tourists to watch them in close quarters. In recent times, lion-tailed macaques of this region have become a major tourist attraction especially among the wildlife tourists and photographers. Various private home-stays in Valparai town, tourist bungalows run by tea companies are attracting their guests by showcasing the natural beauty of the landscape and its wildlife including lion-tailed macaques on their websites and brochures. At the same time, the higher tourist influx has led to more frequent incidents of people trying to feed the macaques (out of carelessness, misplaced concern, or as a source of entertainment). Open, unsegregated garbage disposal and lack of collection of disposed garbage by the municipality is also accentuating the problems. While conflicts are most serious in Puthuthottam estate and adjoining colonies in Valparai town, such human – macaque interactions in the other rainforest fragments, Korangumudi and Old Valparai, are either unknown or far more sporadic. Resolving conflicts at an initial stage is vital to promote coexistence and retain and enhance tolerance of people towards these endangered primates.

Conservation efforts so far

As part of a rainforest restoration programme of the Nature Conservation Foundation in the landscape (Mudappa et al. 2014), the following macaque conservation efforts have been carried out from our long-term field station at Valparai, Anamalai hills, since 2006.

- *LTM Watch:* On the main highway to Valparai, passing through Puthuthottam, two full-time watchers are employed to regulate (slow) the traffic when macaques are on the road, and inform and educate tourists and prevent feeding of monkeys.
- *Canopy Bridges:* During 2011 – 13, with support from the TN Forest Department, we installed 7 canopy bridges in two rainforest fragments (Puthuthottam – 6, Old Valparai – 1) at locations where lion-tailed macaques were known to frequently cross and where natural tree canopy connectivity was absent or low. These bridges are now used regularly by lion-tailed macaques and other arboreal mammals to cross the road.
- *Speed breakers in Puthuthottam:* We had suggested to Highways and Forest Department authorities to construct speed bumps in strategic locations on the main road which goes through Puthuthottam rainforest fragment. As a result, six speed bumps were built in March 2015.



Top left: Lion-tailed macaque electrocuted on powerline; **Top right:** Macaques crossing on canopy bridge; **Bottom:** road widening and increased tourist traffic has brought people and macaques into regular contact along the main road (LTM watcher K. Kannan in the background with placard).

Methods

Between January and May 2015, we conducted household level attitude surveys in the settlements in and near three rainforest fragments namely Puthuthottam, Korangumudi, and Old Valparai (earlier known as Tata Finley) where lion-tailed macaques occur. We have also conducted this survey in a part of Valparai town close to Puthuthottam, which lion-tailed macaques are known to frequent (Figure 1).

A questionnaire for residents was prepared (see Appendix 1) to identify perceptions and score attitudes (ranging from positive and neutral to negative) towards these primates. We also categorised respondents (Male, Female, Estate Workers, Managerial staff, non managerial staff, etc.) and noted other details such as employment of the interviewee, nature of conflict incidents, frequency of visit of lion-tailed macaques near their settlements, response to the presence of the lion-tailed macaques near their residence, history of visits, and other stakeholder responses and solutions offered. Apart from these details, type of roof (tiles, asbestos and concrete) of the interviewee's residence were also noted.

Survey was conducted mainly during the evening or late evening or on Sundays when local people were at their residence as most of the residents work in tea estates during the day. The questionnaire was passed through the internal ethics committee of the Nature Conservation Foundation. The interviews were conducted only if the interviewees were willing to participate. All interviews were conducted by one person and in the local language, Tamil. In few cases (less than 3%) interview was conducted in Hindi as the respondents were workers from north India. Although there were set of questions asked directly to get certain details, the interview was conducted mostly in the form of a dialogue from which the interviewer noted down and scored for attitudes.

Attitude was inferred and scored based on the responses while in a dialogue with the interviewee, noting his/her general perception of the lion-tailed macaques, reactions to the presence of macaques near their homes, and their behaviour and activities when the macaques come close their houses. For instance, during the dialogue connotations included words like "nuisance", "problem" and also the intensity in which these words and the statement have been used during the dialogue were scored as '-1' indicating the negative attitude. Positive statement such as, "they are poor things", "no problem with them around" were scored as '+1' indicating a positive attitude. People who were indifferent to the macaques' presence near their houses or those who did not make statements that were positive or negative and those not aware of the presence of the macaques were scored as '0' indicating a neutral attitude. Interviews with Puthuthottam respondents tended to be longer as macaques frequented this area more and other aspects such as frequency of interactions, boldness of individual macaques, and measures implemented to avoid macaques were described by and discussed with respondents.

Results

Respondents from 220 households in Korangumudi, Old Valparai and Puthuthottam were interviewed (Table 1). In Puthuthottam, besides 87 households in the estate (Puthu Padi, 10 Acres Padi, Kuthirai Padi, Potti Mesthri Padi, Sella Mesthri Padi and Naikar Padi), we also interviewed respondents in 19 households in PAP colony, and 30 households in adjoining parts of Valparai town (Table 1), an area adjoining Puthuthottam rainforest fragment and estate where the lion-tailed macaque troops frequent.

Table 1: Number of interviews conducted in and around main study locations where lion-tailed macaques troops occur in Valparai plateau.

Place	Households
Korangumudi	34
Old Valparai	50
Puthuthottam	136*
Total	220

*This included 87 households in the estate, 19 households in PAP colony, and 30 households in adjoining parts of Valparai town.

Awareness on the status, distribution, and occurrence of the lion-tailed macaques

Out of the total (n=220) respondents 97.2% of them were not aware of the importance, status and distribution of the lion-tailed macaques. Interestingly, 14% of the respondents were not aware of the existence of the lion-tailed macaque. These respondents are mainly from Korangumudi and Old Valparai area. In Korangumudi, of 34 respondents interviewed, only 12 were aware of the existence of the lion-tailed macaque in the area, but had not seen them in Korangumudi rainforest fragment or near their houses but instead recalled seeing them in rainforest fragments far away from their residence. This is probably because the Korangumudi troop is relatively shy unlike the Puthuthottam troop and mainly known to inhabit the canopy and interior of the rainforest fragment and the adjoining coffee estates. Most (82%) of respondents in Old Valparai were aware of lion-tailed macaques, but these were of troops in rainforest fragments far away from their residence. As expected, all respondents of Puthuthottam and nearby areas were aware of lion-tailed macaques, since at least one of the troops here comes close to the human habitations frequently (Figure 2).

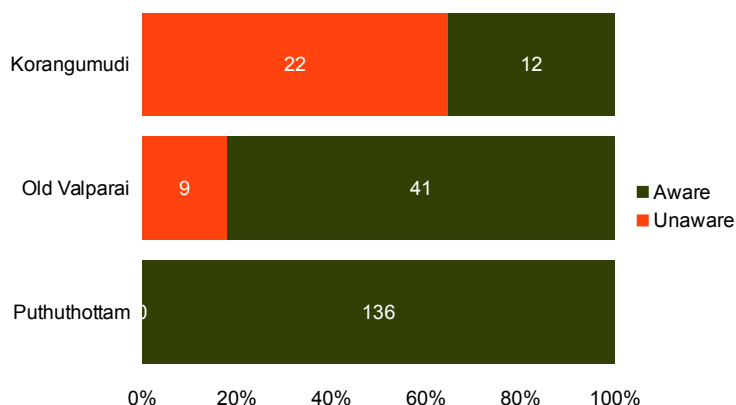


Figure 2: Percentage of respondents aware of lion-tailed macaques in the study locations. (Number of respondents indicated within the bars).

Perception towards lion-tailed macaques

Perception towards macaques varied across sites and also in relation to whether macaques had been seen near or far away from homes. In Korangumudi, none of the respondents had seen the lion-tailed macaques near human habitations and the respondents were neutral in their perception (Figure 3). In Old Valparai, 41 respondents were aware of lion-tailed macaques and although there was some variation in perception among them, 97.5% were neutral. A majority (75.6%) of these respondents have not seen lion-tailed macaques close to their houses, but were aware of macaques in other far away rainforest fragments. The remainder (22%) have seen two individual lion-tailed macaques that sometimes come close to habitations in this area. Two respondents (3%) were positive towards macaques and had come across the two individuals. In Puthuthottam, a majority (67.6%) of the 136 respondents were negative about the presence of lion-tailed macaques. However, 22% of the respondents had neutral and 10.2% had positive perceptions towards the lion-tailed macaques (Figure 3).

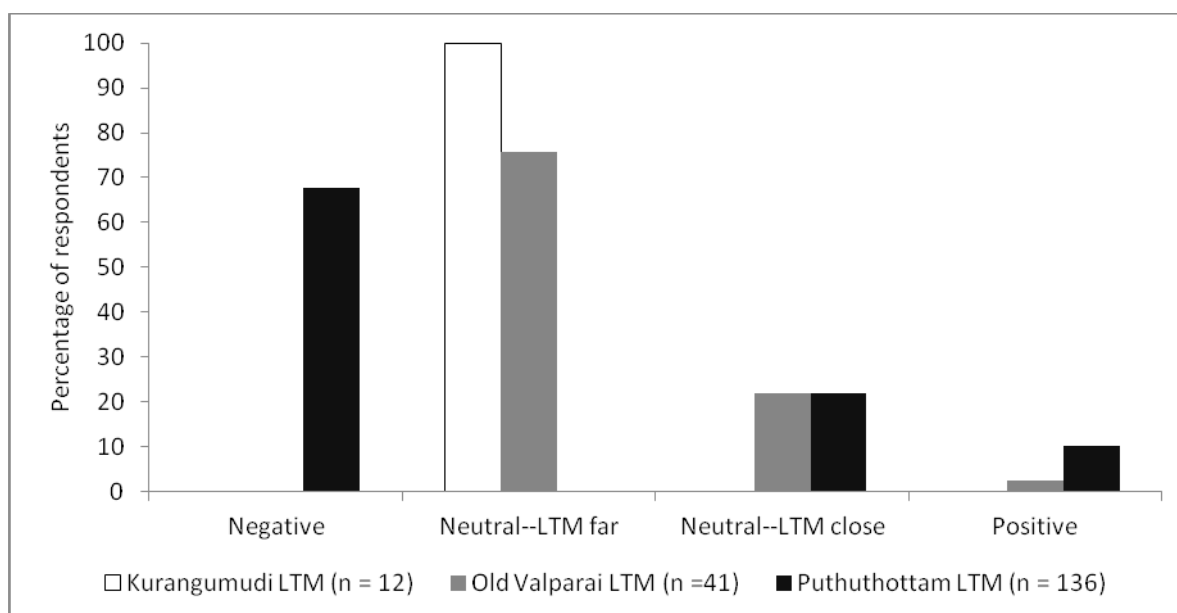


Figure 3: Perceptions towards lion-tailed macaques in three study locations in Valparai landscape.

Housing condition and perceptions towards lion-tailed macaques

For respondents in Puthuthottam and Valparai, during the interview, the type of the roof (tiled, asbestos, or concrete) of the respondent's residence was noted. Of the 87 occupied houses in Puthuthottam estate where the interviews were conducted, 55.2% of them are with tiled roofs and the rest (44.8%) are asbestos. Of the 58 respondents living in tiled-roof houses, most (84.5%) were negative in their **general perception** towards lion-tailed macaques (Figure 4). In recent times, the lion-tailed macaques have learned to remove/move the tiles on the roof to enter the houses to access the food especially when the residents are away from their homes at work. Respondents living in asbestos-roof houses also had negative general perceptions towards the lion-tailed macaques, although relatively less (61.2%) when compared to the respondents in tiled-roof

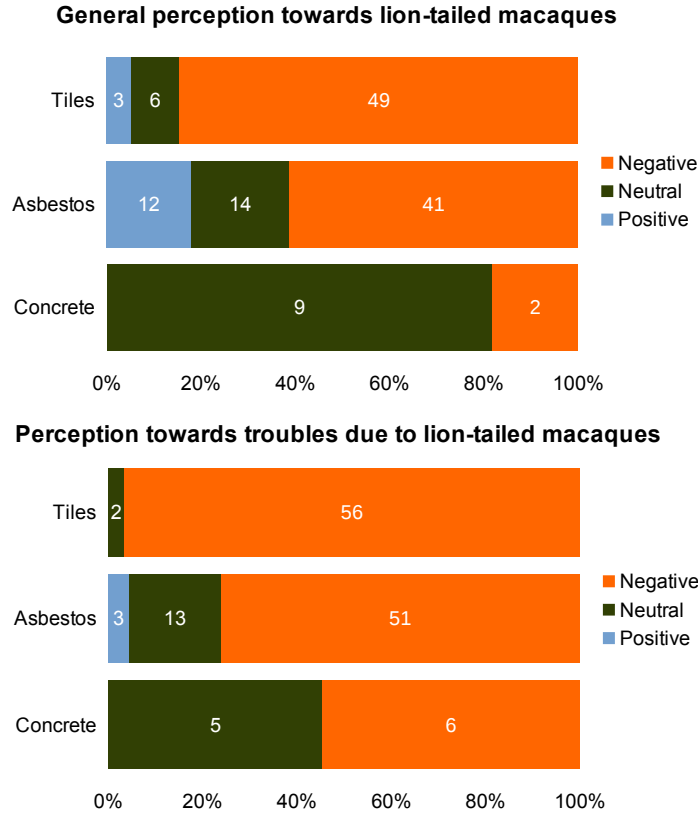


Figure 4: Housing condition and perceptions of residents towards lion-tailed macaques in Puthuthottam and Valparai.

houses. Interestingly, many respondents (both in tiled-roof and asbestos-roof houses) also had positive attitude (see Discussion for reasons). Respondents living in concrete-roofed housing were largely neutral (81.8%) but some were negative.

This pattern was accentuated in people's **perception towards troublesome incidents** due to lion-tailed macaques. Irrespective of housing condition, most respondents (>50%, all roofs types) had a negative perception towards macaque trouble incidents (Figure 4). Interestingly, few respondents living in houses with asbestos roofs were positive even in the light of incidents involving macaques. However, these respondents were people living outside the Puthuthottam rainforest fragment and estate.

We also examined differences in responses between estate and town residents. More respondents (87.4%) living within Puthuthottam tended to be negative than in neighbouring areas of Valparai town (32.7%), where several respondents were neutral or positive. Perceptions may have also been related to frequency of encounter with lion-tailed macaques near habitations. Of 136 respondents, most (122) believed the macaques come near human habitation once in a few days, while 11 respondents said once in a fortnight, and only 3 said everyday. Over three-fourths of the respondents who encounter the lion-tailed macaques near their houses once in a few days or everyday tended to have more negative perceptions towards the species, whereas over 80% of those who encountered macaques only once in a fortnight tended to hold neutral perceptions.

Reasons for macaque visitation

When asked their opinion on the reason for lion-tailed macaques to visit human habitations, most of the respondents (87%) mentioned that the macaques visit the habitations in search of food and garbage (Figure 5). Few respondents (8%) mentioned that they were seen close to human habitations because tourists, photographers, and in one case a researcher, all of whom according to the respondents either fed the macaques directly or discarded food that attracted macaques. A couple of lion-tailed macaque individuals (adult males) were

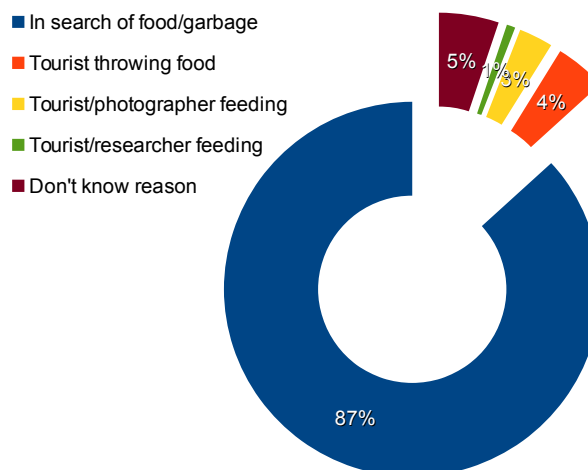


Figure 5: People's perceptions on reasons for lion-tailed macaques coming near human habitations.

reported by a few respondents as having become bold, approaching people apparently without fear to seek food, or in the case of one individual even reported to snatch food and garbage from people's hands. When asked how many individuals show such behaviour, 60% of the respondents mentioned that only a few individuals are bold, whereas 38% of the respondents mentioned that none of them are bold. Of 136 respondents, only 2% mentioned that many individuals are bold.

History of macaque visitation in Puthuthottam

Since when have macaques been visiting habitations in Puthuthottam area and when did the negative interactions with people begin? We asked respondents about this while also recording the number of years they were resident in Puthuthottam (Figure 6). Most (84%) of the 136 respondents mentioned that lion-tailed macaques were frequenting human habitations only within

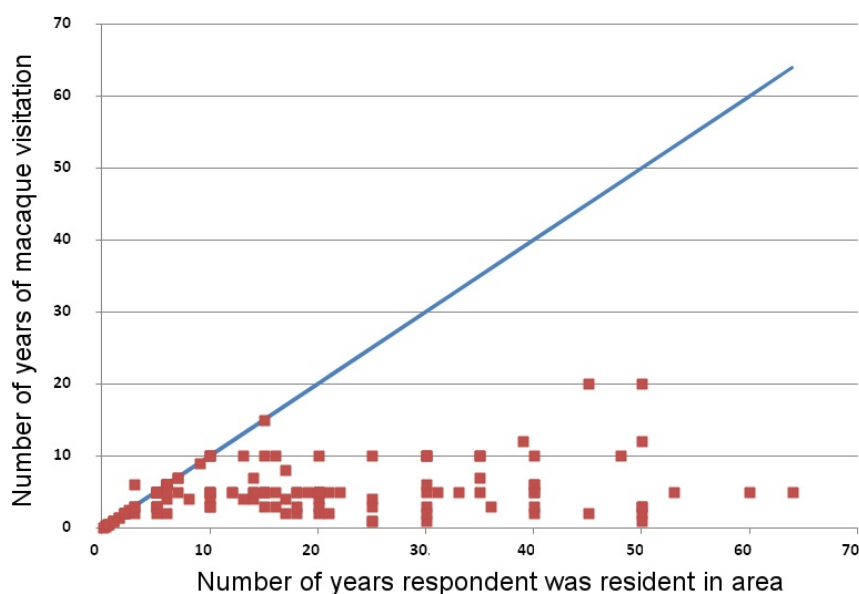


Figure 6: Respondent's duration of residence in Puthuthottam and nearby areas in relation to their perception of history of visits by lion-tailed macaques near habitations. Most points fall well below the straight line ($y=x$), which merely indicates that even though a majority of people have been resident for over a decade, most of them report macaques near habitats only within the last ten years.

the last 10 years (within last 1 year: 4%; last 1 – 4 years: 37%; last 5 – 9 years: 43%). Only two respondents (1%) mentioned that macaques were frequenting the area over the last 20 years; possibly because both these respondents lived close to the forest edge in 10 Acres Padi and would have noted macaques near their houses for a longer period when compared to the other residents. Two respondents (1%) did not know how long the macaques had been visiting their area, and 1 reported a 15 – 20 year period.

Virtually all respondents reported macaques over a period that fell within their own duration of residence in the area. **It was clear, however, that most respondents, resident here for a long period (from 10 to 64 years), reported that lion-tailed macaques had been visiting the vicinity of human habitations only within the last 10 years (Figure 6).**

Discussion and Recommendations

Based on this survey and interactions with people living in/close to areas inhabited by the endangered lion-tailed macaques, we infer the following:

1. There is a low level of awareness on lion-tailed macaques among sections of the residents and the public that needs to be addressed.
2. Perceptions towards macaques tend to be more negative in areas with more frequent encounters. However, many people are still neutral or positive about the macaques.
3. Improper garbage disposal and tourists (especially those feeding monkeys) are seen as the main reason for greater time spent by monkeys close to people.
4. Tiled-roof houses, in particular, and asbestos-roof houses are more prone to incursion by macaques.
5. Past fragmentation and ongoing habitat degradation has contributed to macaques coming to the ground and directly interacting with people more often.

Understanding this is crucial to develop scientific, locally appropriate, and socially acceptable measures to reduce negative interactions between people and macaques in the future.

Lion-tailed macaques in Korangumudi and Old Valparai

Lion-tailed macaques of Korangumudi rainforest fragment do not venture close to any nearby human habitation. Hence several of the respondents were not aware of this species' existence. Respondents living at the edge of the rainforest fragment reported that Nilgiri langur (*Semnopithecus johnii*) do come close to human habitations occasionally, especially if there are any fruiting trees such as jack (*Artocarpus heterophyllus*) and guava (*Psidium guajava*). It was reported that although they were seen at the fruiting trees they are all shy and flee at the sight of people. Another primate species that occurs in this area is the bonnet macaque *Macaca radiata*; but they are also seen infrequently. It was evident from that the respondents are largely neutral towards all the primates that occur in this region.

In Old Valparai, perception towards lion-tailed macaques was mainly positive or neutral because the monkeys largely stayed in the nearby rainforest fragment and adjoining native shade

coffee estate; only two individuals infrequently came near human habitations in this area. In some places, Nilgiri langurs do come close to the human habitations but were reported to be shy. Many respondents from two settlements in this region (Old Valparai and Varattuparai) had negative perceptions towards bonnet macaques as they do sometimes enter their houses, which they attributed to the presence of open cattle sheds that bonnet macaques enter to consume leftover food (mainly rice) meant for cattle.

Lion-tailed macaques in Puthuthottam

Respondents from in and around Puthuthottam reported that they come across Nilgiri langur very rarely and bonnet macaques occasionally. Lion-tailed macaques frequent many of the human habitations within Puthuthottam estate, the rainforest fragment, and occasionally some parts of Valparai town. As the respondents of Puthuthottam settlements reported, the lion-tailed macaques are frequently seen near the human habitations in search of food and this phenomenon is fairly recent (within last 10 years). This corresponds to a period of increased influx of casual tourists to Valparai along the main highway (widened in recent years) passing through the rainforest fragment. The lack of tree canopy connectivity (over the road) in many places forces macaques to cross the road on the ground and poor garbage disposal (tourists throwing food by the side of the road, residents throwing food close to human habitations) attracted macaques and brought them into greater contact with human foods and habitations.

Deliberate or careless feeding of macaques by tourists/visitors along the road and improper/open garbage disposal were seen by the residents as a primary reason for the macaques visiting housing areas. Most of respondents mentioned that, earlier, lion-tailed macaques were quite shy and never ventured very close to the human habitations. Few respondents mentioned that, in the past, they actively fed some of the macaques near their habitations and some still continue to feed them. Once the lion-tailed macaques were thus habituated, they started entering houses through the main doors and windows.

It was evident from the responses that the housing conditions influenced residents' perceptions towards lion-tailed macaques. Many tiled-roof houses have chimneys through which lion-tailed macaques sometimes enter the house. In recent times, some individual macaques have also learned to lift roof tiles to enter houses. Asbestos-roofed houses are better protected but lion-tailed macaques sometimes enter through the chimney or through main doors left open, besides using gaps between the roof and the wall. The connection between perception and housing suggests that measures to monkey-proof the houses is likely to assist in both reducing the troublesome incidents involving macaques and enhance people's perception towards macaques. Simple, cost-effective measures appear to be available and some are already being deployed by local people.

Measures taken by residents to avoid lion-tailed macaques entering their houses

In some places, residents stay vigilant when at home and chase away the macaques when they come close by shouting, waving a stick, throwing stones, using a catapult, or splashing hot water

when they approach close to their houses. However, as most residents work in the estates away from their home during much of the day, such prevention measures were not always possible. It was during such times that macaques enter the locked houses in search of food, causing losses, food spillage, or other damages. A few residents also mentioned that they had stopped maintaining their kitchen gardens and cut down guava trees since they were attracting the macaques. Besides the reactive and preventive measures, many residents also made specific changes within their houses as monkey-proofing measures:

Tiled-roof houses:

- Many houses blocked the entrance of the chimney (note: weld mesh can be used to retain ventilation while blocking entry of macaques).
- Several houses have false ceilings inside their houses. These false ceilings are made using plastic sacks, cardboard sheets, and paper.
- There were instances of lion-tailed macaques entering and tearing through false ceilings made of plastic sacks and paper. Some residents therefore used tin sheets and wooden planks which are much sturdier than the other materials. However, tin and wood are costlier and are unaffordable for many residents.
- Most estate worker houses have only two rooms and the false ceiling was made only in the main room. False ceiling cannot be fixed in the kitchen as most households use wood stoves for cooking and there is no outlet for the smoke except for the windows/chimney. There are recent reports that lion-tailed macaques open the tiles on top of the kitchen and enter inside.
- In houses with the false ceiling, some people reported that, before they leave for work they shift the food materials from the kitchen to the main room and lock the kitchen door which helps to keep it safe.

Asbestos-roof houses:

- Many houses have now either blocked the chimney opening or removed the chimney.
- There is a gap (along the eaves) between the roof and the main wall running along the front and back of most houses. Several residents effectively blocked these gaps by using wooden planks or chicken wire mesh.
- Although lion-tailed macaques cannot open the asbestos sheets on the roof, people claimed that the sheets sometimes break when the macaques jump on the roof. Hence in few houses residents made a false ceiling to avoid rainwater leaking inside during the monsoon.
- One of the residents mentioned that they covered the asbestos roof and the chimney with the flex plastic sheet. However, it wasn't effective since macaques sometimes bite and tear the sheet. Some of the residents suggested that covering the tiles and asbestos roofs with the tarpaulin sheets. But none of them have tried this thus far since it is expensive.

Recommendations

The results of our survey leads us to suggest four broad measures that will help facilitate coexistence between people and the endangered lion-tailed macaques:

1. Improving housing through monkey-proofing measures
2. Improving garbage disposal in Puthuthottam and Paralai
3. Building awareness on specific issues
4. Ecological restoration of rainforest fragment and retention of native shade trees in plantations

1. Improving housing through monkey-proofing measures

This can be achieved by appropriately reinforcing existing structures as a key measure. There is also an urgency to reinforce specific residences with monkey-proof structures in the colonies within Puthuthottam estate and rainforest fragment.

There are 46 individual houses with tiled roof and 35 with asbestos roof in 6 locations within Puthuthottam rainforest fragment (Table 3). We suggest that all these houses are jointly inspected by the plantation company management, taking the assistance of the TN Forest Department and NCF researchers familiar with macaques in the area, and assessed in order to prioritize further necessary interventions related to monkey-proofing. Since several residents are already adopting various techniques it is appropriate to follow those methods in monkey-proofing with required modifications. Keeping this in mind, improving the methods that are already in practice is likely to receive acceptance by the community.

Table 3. Number of houses in six colonies within Puthuthottam estate that require better monkey-proofing structures.

No.	Location	Tiled roof	Asbestos roof
1	10 Acre	10	4
2	Potti Meshtri Padi	9	0
3	Sella Meshtri Padi	2	4
4	Puthu Padi	17	21
5	Naikar Padi	8	0
6	Kuthirai Padi	0	6
Total		46	35

Some of the monkey-proofing methods that can be jointly implemented along with the local stakeholders and community (including plantation management, residents, NGOs, and Forest Department) are:

- Providing sturdier materials for false ceiling especially for tiled-roof houses.
- Blocking the gaps (along the eaves) between the main wall and the asbestos roof with chicken wire or weld mesh, since this will retain ventilation.
- Covering the windows with chicken wire mesh.

- Draping the tiled roofs with chicken wire mesh of an appropriate gauge that is strong yet flexible. This would be sturdier than the flex plastic sheets and tarpaulin sheets. This would ensure that the macaques are not able to remove/move the tiles.
- Frame door with weld mesh outside the main (wooden) door with automatic spring closing. This would enable people to keep open their main door for ventilation while the outside mesh door would be shut and prevent macaques from entering the house.
- Similar steps should be taken at Iyerpadi hospital to prevent monkeys from entering the hospital wards

2. Improving garbage disposal in Puthuthottam and Paralai

A number of other measures need to be implemented or strengthened in relation to garbage disposal and awareness:

- Tourists, visitors, and residents of Puthuthottam should be made aware of the ill effects of open garbage disposal and encouraged to improve the waste disposal system by providing training and support to manage solid and organic waste.
- Tourists should be strictly prevented from carrying food items into the field and feeding monkeys, especially along roads, at viewing platforms and eco-lodges, and near housing. Tourist guides should also be instructed and trained in informing visitors on the need to avoid feeding monkeys either deliberately or accidentally.
- Some measures have already been taken by various companies in the landscape to segregate and collect garbage regularly at the colony level. These measures can be continued and expanded to ensure complete coverage.
- Measures need to be taken to prevent monkeys from accessing medical waste pits and garbage around Iyerpadi hospital and to remove garbage produced around the roadside stalls
- The municipality also needs to provide waste bins and collect garbage on regular basis from the Puthuthottam estate colonies, which is yet to be implemented.

3. Building awareness on specific issues

- All the stakeholders of this region (local residents, tourists, researchers, wildlife photographers) should be educated on ill effects of feeding the macaques.
- Educating the residents of Puthuthottam estate and Valparai town on the importance, conservation status, and distribution of the lion-tailed macaque is also essential.
- Continuous awareness and training is also required on waste segregation and disposal practices.

4. Ecological restoration of rainforest fragment and retention of native shade trees in plantations

- A key long-term need is to facilitate the recovery of rainforest vegetation (including food species) through appropriate ecological restoration measures in the rainforest fragments, particularly Puthuthottam and Korangumudi. The restoration of tree canopy structure,

continuity, and diversity of native tree species will assist this arboreal primate to meet its food and ranging requirements, and minimise the incidence of macaques coming to the ground to feed or engage in negative interactions with humans. An ongoing long-term rainforest restoration project in the region has developed effective protocols and identified suitable mix of native rainforest tree and other woody plant species for such ecological restoration (Mudappa and Raman 2010).

- A list of 20 select lion-tailed macaque natural food species (based on long-term research in the Anamalai region), for which seedlings are presently available in the NCF rainforest plant nursery, is provided in Appendix 2. These species, which include important fruiting trees, such as *Cullenia exarillata* (Tamil: vedi pila or korangu pila), can be particularly targeted for restoration planting in Puthuthottam and Korangumudi, including along the roads.
- There are also a large number of native shade trees, including jackfruit, *Cullenia exarillata*, *Mesua ferrea* and other species, in the old coffee areas and recent tea fields. These trees should be protected and future shade planting in coffee and tea areas could more frequently include suitable native shade tree species (in addition to silver oak).

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Appendix 1

Questionnaire used for attitude survey to identify perceptions towards lion-tailed macaques in Valparai plateau.

Questionnaire for LTM's
Name: _____
Address: _____
Family Size _____ Employment _____
1. How often do you see LTM's and where?
2. Every Day _____ once in a week _____ Once in Fortnight _____ Once a Month _____ Few times (>5 times) a year _____
3. When was the last time LTM came near your house Date / Month _____ And the one before Date / Month _____
4. What do the LTM's do when they come close to your house?
5. What do you do when you see them around your house?
6. How long you have been living here?
7. How long they have been around?
8. Since how many years have LTM's visited around your house? 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ More than 5 _____
9. Is there any change in their behavior over the years? Entering houses? (If so how? _____) Aggressive?
10. Why do you think they are visiting your area?
11. Where else do you think this LTM occur in this world? And do you know how many of them are there in the world?

Appendix 2

List of 20 important lion-tailed macaque food species presently available for restoration planting in NCF rainforest plant species nursery at Varattuparai.

1. *Antidesma menasu*
2. *Artocarpus heterophyllus*
3. *Bischofia javanica*
4. *Chrysophyllum lanceolatum*
5. *Cullenia exarillata*
6. *Diospyros sylvatica*
7. *Dysoxylum malabaricum*
8. *Elaeocarpus munronii*
9. *Elaeocarpus serratus*
10. *Ficus species*
11. *Litsea oleoides*
12. *Litsea stocksii*
13. *Macaranga peltata*
14. *Maesa indica*
15. *Myristica dactyloides*
16. *Palaquium ellipticum*
17. *Semecarpus travancorica*
18. *Syzygium cumuni*
19. *Syzygium gardneri*
20. *Villebrunea integrifolia*